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ABSTRACT

This document reports the development and evaluation of "Patterns," a unit in the Preprimary Mathematics Program developed within the University of Georgia Research and Development Center in Early Educational Stimulation. An attempt was made to determine the appropriateness of the activities in the unit for children three, four, and five years of age, the instructional time required for the unit, and the degree to which the objectives of the unit were accomplished. Results showed that the unit was teachable and successful in accomplishing the goals of instruction; the time taken for the unit varied with different age groups. For the unit "Patterns," see SE 016 129; for the other units in this series, see SE 016 124 through SE 016 128. (DT)

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Technical Paper No. 13

DEVELOPING AND EVALUATING "PATTERNS"

William D. McKillip

July, 1970

Research and Development Center in Educational Stimulation
University of Georgia Athens, Georgia

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DEVELOPING AND EVALUATING "PATTERNS"

by

William D. McKillip

R & D Center in Educational Stimulation

Prepared for the
Mathematics Program - William D. McKillip, Coordinator
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July, 1970

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DEVELOPING AND EVALUATING "PATTERNS"

INTRODUCTION

The unit Patterns is a part of the Preprimary Mathematics Program which was developed within the University of Georgia Research and Development Center in Early Educational Stimulation. The first writing of the unit was done in the Spring of 1969 and preliminary trials were conducted during the late Spring and Summer of that year. The unit was rewritten in a revised and expanded form utilizing feedback from the preliminary trials.

In January and February of 1970 the unit was used by the preprimary classes in the Research and Development Center's experimental school in Clayton County, Georgia. An evaluation of the unit was conducted at that time in an attempt to determine the appropriateness of the activities in the unit for children three, four, and five years old, the instructional time required for the unit, and the degree to which the objectives of the unit were accomplished. On the basis of that information it was anticipated that further modification of the unit, particularly in its relationship to the entire program, would be done.

GENERAL SETTING

Arnold School. The Research and Development Center in Early Educational Stimulation has, since the fall of 1966, operated an experimental preprimary and primary school in Clayton County, Georgia. During the 1969-70 school year this program was housed in the Arnold School. Prior to the 1969-70 school year this program was housed in the Suder School, however the teachers and students were the same as in previous years except for normal turnover in teachers, the loss of a few students, and the addition of a new group of three year olds.

The classes at the preprimary level (ages 3, 4, and 5) were composed of 15 to 20 children, and for each class one teacher and two teacher aides were provided. At the primary level classes were larger, 16 to 27 children, and one aide was provided for each class. In each of the seven subject matter areas, language, mathematics, science, social science, art, music, and physical education, there was a subject matter specialist in the school to assist the teachers, supervise the use of materials, conduct inservice training for teachers and aides, administer tests, and collect data. Assistance from a faculty member in the subject matter department of the College of Education (for example, Mathematics Education) or the appropriate department in the College of Arts and Sciences was available when needed. This faculty member had the responsibility for developing and/or selecting materials for use in his field. At the preprimary level the children attended school on half day sessions with each team (teacher and two aides) handling two classes, 8:30 A.M. to 11:00 A.M. and 12:00 P.M. to 2:30 P.M., each day. Preprimary classes met four days per week, reserving Wednesday of each week for planning, updating of records, and inservice education. All teachers but one scheduled fifteen minutes per

subject each day. This had the effect of reducing expected variation in lesson length. The single teacher who operated on a flexible schedule had mathematics lessons during the unit varying from 0 to 40 minutes.

Pre-primary Population.[1] The subjects in this evaluation were the children enrolled in the preprimary classes at the Arnold School. All of these children entered the R & D Center's preprimary unit at age 3, that is, the children ranged in age from 2 years 9 months to 3 years 8 months in September of the year they entered.

Parents volunteered to have their children enrolled in the preprimary classes and provided transportation. No tuition was charged. The enrollment period was heavily advertised each year in order to secure a large number of applicants. Parents who had one child enrolled were given priority in enrolling other children if they wanted to do so. The selection procedure varied only slightly from year to year for successive groups of three year olds. The measures obtained on applicants and used for selection purposes were, for years before 1969, chronological age, parents socio-economic status, ethnic group, and verbal maturity as measured by the Peabody Picture Vocabulary Test. Through selection of subjects an effort was made to produce a group which was approximately a "national sample" in regard to these measures.

All children in the three and four year old groups were used in this trial. The children in the "top third" of the five year old group, teacher judgement serving as the selection factor, were doing first grade level work and it was decided that they should continue in the first grade program

[1]The information regarding population was obtained from the R & D Center publication, "Basic Assessment of Subjects in the Clayton County Model," undated, mimeographed.

rather than start the Patterns unit.

The IQ scores given in Table 1 are based on the Stanford-Binet Intelligence Scale. Note that the reduced five year old population from which the "top third" of the group has been eliminated is very little different from the total group. In any case, this population is not really comparable to any other population of five year olds known to this investigator. They have been in school since age three in an environment which emphasizes structured cognitively oriented programs in subject matter areas.

Pre-primary Mathematics Program. The pre-primary mathematics program of the Research and Development Center was designed to develop understanding of basic mathematical concepts through a sequence of informal experiences. In preliminary form the program consisted of the separate units Matching, Counting, Patterns, Relations, Operations, and Numeration. This sequence of units was used at the Arnold School, the R & D Center's experimental primary and pre-primary school, and at several other locations in the South and East. Teachers were adapting one basic set of materials to suit children three, four and five years old. The use of units based on mathematical topics was a convenient arrangement for production, trial, and evaluation, but it was less convenient for instruction in the three to five age range as the material was, by teacher report, most suitable for age four but required considerable adaptation at age 3. It was expected that the successful parts of the units would be absorbed into programs organized by age level.

The unit being considered in detail here, Patterns, is based on manipulating red and white cubical blocks to form patterns. It consists of five activity sequences each of which takes an activity from simpler to more complex patterns. A description of the major activities follows.

TABLE 1

Numbers in Each IQ Level by Class[a]

Class	Date Tested	Intelligence Level 150-159	140-149	130-139	120-129	110-119	100-109	90-99	80-89	70-79	N[b]	Mean
1972 (3-year-olds)	6-69	0	0	3	4	12	17	14	11	0	61	103.3
1971 (4-year-olds)	10-69	0	0	11	14	26	19	5	0	0	75	121.7
1970 (5-year-olds)	2-68	0	0	5	17	21	11	2	0	0	56	116.6
Reduced 5 year old Population	2-68	0	0	2	10	14	9[c]	2[c]	0	0	37	114.7

[a]Adapted from "Basic Assessment of Subjects in the Clayton County Model," undated, mimeographed.

[b]The total N varied from one testing to another, since not all children were present each time.

[c]One of these IQ scores based on P.P.V.T.

The children are allowed to play with the blocks for some time preceding the beginning of organized activities. When they have had an opportunity to manipulate the material as they wish, to "get the feel" of it, they will be willing to begin more directed activities.

The first activity in which the students are directed by the teacher is the copying of patterns. The teacher makes a pattern using blocks and the children attempt to make an exact copy of this pattern. When the children have learned to copy simple patterns, a new element is introduced, a book of patterns from which the children are to copy. Two pages from this book are reproduced here. The patterns in figure 1 are relatively uncomplicated; figure 2 is more complex.

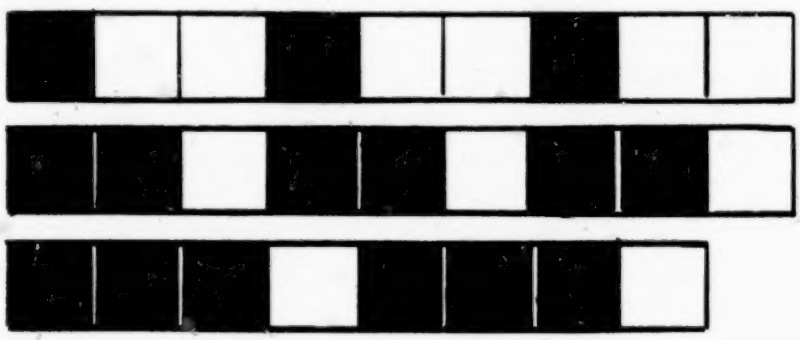

Figure 1

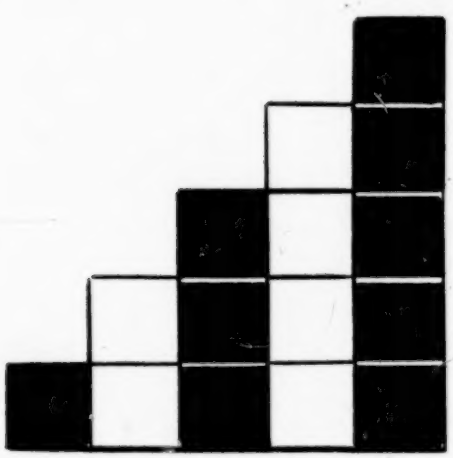

Figure 2

The second activity, after copying patterns, is to extend them. A pattern is extended by following the established pattern in further repetitions of the repeating part. While a pattern can be copied in a mechanical fashion (looking at the pattern and duplicating it block by block), no such strategy will work in extending a pattern. The student must be aware of the existence of the pattern in order to extend it. Two pattern types are used in the unit: One is the repeating pattern, for example figure 3, and the other is a variable pattern such as figure 4.

Figure 3

Figure 4

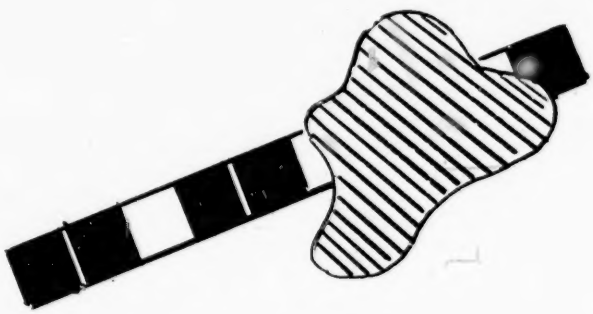

Figure 5

Further practice in extending patterns is given using worksheets like the one shown in figure 5. A pattern is started and produced far enough for children to recognize it, and then a blot on the sheet conceals one or more of the blocks. The students continue the pattern for a block or farther and then, if they are correct, are reassured by finding that the blocks match one or more which show at the end.

Other group and individual activities are included in the instructional treatment. For a more complete description of the unit see the January, 1970, issue of The Arithmetic Teacher or the unit itself.[2]

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[2]William D. McKillip, "Patterns - A Mathematics Unit For Three- and Four-year-olds," The Arithmetic Teacher, January, 1970, pp. 15-18; "Patterns," Practical Paper No. 32, Research and Development Center in Educational Stimulation, University of Georgia, Athens, Georgia, December, 1969.

Limitations. The general setting had both positive and negative aspects. The resources for the implementation of an instructional program at Arnold School were excellent. The number of adults, teachers and aides, in the classrooms made possible a high degree of individualization of instruction and also made it possible for detailed records to be kept on the progress of instruction. The presence of a subject matter specialist in the building at all times helped to insure a high degree of conformity to the planned course of instruction and a high degree of understanding of the objectives of the instruction on the part of the teachers and aides. Many of the aides and teachers had been teaching in the program for three years prior to the 1969-70 academic year and exhibited great skill in teaching young children.

The organization of the classes and the "established routine" of school operation which seems desirable in dealing effectively with children at the pre-primary level limited the flexibility in presentation of the material. Only one pre-primary classroom was so organized that a flexible time schedule could be employed.

Previously it had been decided to provide the same total curriculum for all pre-primary children, and there was no group available to serve as a control group. Consequently, there are a number of possible explanations for the apparent effects of instruction. While recognizing this defect, the revision planned for this material will be carried out on the basis of this evaluation as it represents the best available information on the unit.

DEVELOPMENT AND PRELIMINARY TRIALS

The objective in the development of this unit was to create a sequence of activities which would attract the interest of young children, hold their attention for a reasonable period of time, and through which some recognizable mathematical objectives could be accomplished. Block play and pattern formation (similar to bead stringing) were selected as the basic activities to be used during the unit. These activities were chosen because children were observed to engage in them voluntarily, without adult intervention, for relatively long periods of time. It was hoped that this approach to the development of the unit would decrease the severity of the problem, frequently observed in the instruction of pre-primary children, of lack of attention to the instructional situation. The attention of a pre-primary child does not seem to be his to give in the sense of his being able to voluntarily direct his attention to something which does not interest him. Even constant exhortation, which seems inappropriate, produces only an appearance of attention.

Another approach to the development of a unit, used in the production of some later units, was the more traditional procedure of writing mathematical objectives and a content outline and then designing the materials and activities to implement the outline. The problems associated with these two approaches seem to be quite different.

Preliminary trials of the unit were conducted in the spring and summer of 1969 in Athens and Augusta, Georgia. It was decided in these trials to investigate the intrinsic appeal and teachability of the unit rather than its effectiveness. It was felt that in order to test the effectiveness of the sequence of activities it was essential to first determine whether the activities could be carried out as described in the unit. A number of factors were involved: Whether the writing was sufficiently clear that teachers could follow the

procedures described, whether the activities were teachable in the sense that a reasonable level of effort would result in success for most children on most tasks, whether the activities were practical in terms of class control, whether the activities were intrinsically interesting as they were intended to be, and whether teachers and children responded positively to the unit as a whole.

Information was gathered during preliminary trials by observing teachers, by obtaining written comments from teachers, and by teaching the materials on occasions when problems were encountered. Teachers using the unit were encouraged to write their comments directly in the booklet. The comments which were received from the teachers were helpful in revising the unit. The next four pages are examples of teachers' comments and the pages from the trial version of the unit to which they relate. The teachers' emphasis on the importance of verbal description was a major factor in the decision to include this activity in the revised edition. In general, reactions of the teachers to the unit were positive, and they reported positive reactions from most children. These positive reactions and the impressions gained by the staff through observation of classes and teaching the material indicated that the unit was satisfactory in terms of intrinsic appeal and teachability. The revision was completed during the fall of 1969 and included suggestions and ideas from a number of faculty members and graduate students as well as the information obtained during preliminary trials.

Activity Sequence 3

Extending Fixed Patterns

Introduction

This activity is the first one which requires a child to decide for himself what block to put in a space rather than just copy. The idea is to teach the child to attend to patterns so that he can predict what the next pattern element will be. For example, in the following row of blocks most people will immediately say that the next block should be _____.

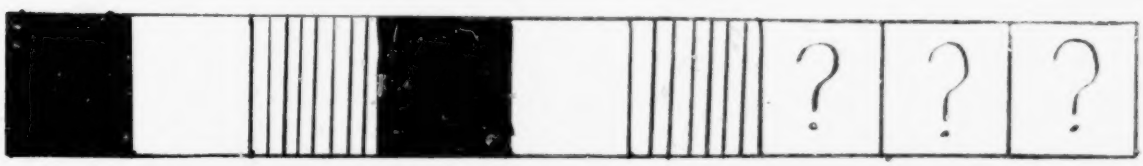

Figure 5

Can children do this task? We shall see!

Objectives

1. The children learn to extend an observed pattern of blocks by continuing the pattern.
2. The children learn to extend patterns seen in a book.

Activities

1. Giving children two or three repetitions of a pattern, ask the children to "Build more like this" or "Make the wall longer." Did you find another instruction which was particularly effective? Write it here: _____

_____

_____

COMMENTS PAGE 14

1. After successfully completing the above, children were asked to create a pattern. Interesting patterns followed.
2. No.
3. The children could do this activity very well. They found it both interesting and enjoyable.
4. Make a long railroad track.
5. Most children had trouble continuing the pattern. Made children repeat name of colors so would see pattern better.
6. I had to talk with mine like one black- one white- one black- etc.
7. I think yours were fine.
8. Some of the children weren't able to make decisions as to which extended pattern to follow. I did not find a better instruction that was more effective. The class as a whole could follow directions better than extend a pattern.
9. Instructions were understood given below.

Use the patterns on page 10, on the work sheets, and in The Duck Book and make up others if you wish. Do the students need to see three or four repetitions of a pattern to be able to extend it or are two repetitions enough? At this point we don't know, but you can try it both ways and find out.

2. In this activity we would like to have children extend patterns in The Duck Book. They should first duplicate the pattern they find there and then extend it.

COMMENTS PAGE 15

1. Six children were able to do pattern extensions immediately. They did them a number of times during the day, but the other six had to be given instructions twice during the same class period, and two never tried to get finished. The other four finally finished with a bit of effort.
2. Mine needed 3 or more repetitions.
3. Mine needed 5 or more repetitions.
4. "Let's get the Duck Book" said two when they first arrived. Doug seems particularly interested. He wanted to make all patterns in book. All children work hard to correct patterns.
5. Children could only extend pattern after verbalizing about it - "pink and green, pink and green, etc."
6. Extending patterns was easy for most of the children.

OBJECTIVES AND RESULTS OF EVALUATION

Objectives

The pre-primary Mathematics Program of the Research and Development Center consists of a series of units, each of which is related to a particular mathematical topic. This organization was adopted because it facilitated rapid production of units and thus it was possible to supply first-draft units as needed during the course of the year.

There are a number of problems associated with the discrete-unit form of organization. Perhaps the most obvious is that the interconnections between the units are not well developed since all of one topic comes before any of another topic; a more desirable organization would be to move back and forth between topics when necessary to emphasize interconnections. With pre-primary children variation of activities is essential in order to maintain interest. While within units the materials of instruction and the form of class organization are varied, the length of time spent on one unit tends to exceed this interest span. Three, four, and five-year-olds need substantially different instructional treatments not only in the level of complexity of the ideas involved but also in the form of class organization and the specific activities which are found to be workable. The units are being used at all pre-primary age levels and the teachers are finding it necessary to do substantial adaptation, particularly at the three year old level.

The objectives of evaluation are related to the state of the program at this time and the direction which revision is to take. It is hoped that in the next revision the program will take the form of one year's work at each of the pre-primary age levels. Production of this type of program from a set of discrete units will involve a great many decisions, most of which will be made on a "best judgement" basis. The information obtained from preliminary

trials and evaluation will, it is hoped, help to indicate, for each age level, answers to the following questions:

1. Can the children perform successfully the sequence of tasks which constitute the instructional unit?
   a. What percentage can perform successfully prior to instruction on these tasks?
   b. What percentage learn to perform successfully during the course of instruction?
2. How much time is required for satisfactory completion of the unit?
3. Is the unit effective in accomplishing the objectives of instruction?

The following sections present the information which has been gathered and the conclusions which seem applicable to the task for revising the unit in the ways described above.

Information From Test Results

The purpose of the testing was to investigate the status of the subjects before instruction and the change during the course of instruction in two areas. The first area was the ability to copy, extend, and describe patterns presented in the instructional mode (patterns of red and white cubical blocks) and to produce a pattern from a verbal description. Patterns used in the instructional treatment were not used in the test but the same materials were used. This test was, in terms of the tasks the children were asked to do, very close to the tasks in which they received instruction. The second area was the ability to extend patterns presented in other modes (variation in shape, size, and number of dots on cards) and appeared to be less like the instructional situation.

It was hypothesized during the development of the unit that experience in working with patterns would increase the child's achievement in recognition of patterns like those used in instruction and also in recognition of other sorts of patterns. The recognition of patterns or regularities was felt to be sufficiently important to an understanding of elementary mathematics to warrant introduction of the topic at the preprimary level.

Interpretation of Tables. Each item was analysed separately; no total score was defined. The headings indicate correct and incorrect responses on pretest and posttest, ++, --, +-, and -+, with the pretest result (+ or -) followed by the posttest result (+ or -). The column headed "% Scoring + on Pretest" tells the percent of subjects who were able to do the task prior to the instructional period.

The subjects scoring - on the pretest, those who were unable to do the task, scored either + or - on the posttest; they were or were not able to do the task following instruction. The column headed "Percent Learning" gives the percent of subjects responding correctly to the item on the posttest within those responding incorrectly to the item on the pretest. That is, of those unable to do the task at first, what percent learned how to do it?

The column headed "Expected Range" gives the percents between which one would expect the "Number Learning" to fall if the unit were used with a similar population. Approximately two times in three the number learning would fall in this range while one time in six fewer would learn and one time in six more would learn. This figure would be more dependable if more subjects had been available for the trial being reported here.

If the instructional unit had no effect it would be expected that changes in score from pretest to posttest from + to - and from - to + would be about

equal in frequency. This, of course, is relative to the limitations described elsewhere. The column headed "Number Changing Positively" presents the significance level of the number changing in the positive direction (-, +) within the group of all subjects changing in either direction (+, - and -, +). The test of significance used here is the binomial test [3]

The first three sections deal with the materials (red and white blocks) used in the instructional phase of the unit. The subjects are tested on the tasks they were learning to do during instruction: copying, describing, and extending patterns. The patterns used in the test and the patterns used for instruction are not the same in any case. The fourth section deals with extending patterns using pattern elements not included in the unit. This is included to investigate improvement in pattern recognition and extension for patterns of sorts other than those used for instruction.

In those cases in which the number of subjects in a particular category is too small to produce a reliable result an asterisk is entered in the table.

Copying Patterns. The task being considered here is that of making a copy of a pattern. If the pattern is reproduced successfully the copy is judged to be correct regardless of the beginning and ending points. An example is given in the figure below. A five item test was used to determine whether or not a child could copy patterns of the sort used in the instructional phase of the unit. The five patterns to be copied had, in the judgment of the developer, approximately the same range of difficulty as the patterns used

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[3] Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences, (New York: McGraw-Hill Book Company, 1956), pp. 36-42.

in instruction; those patterns used in the test were different from those used in the unit, however.

The tables for ages 3, 4, and 5 show a clear progression in ability to do the tasks prior to instruction. The percent of children who scored + on the pretest decreased steadily from age 5 to age 3. The percent scoring + on the pretest was so large at age 5 that no further tests of the effectiveness of the unit were possible. At age 4 the items were worked correctly on the pretest by 38% to 63% of the children. Of those who missed an item on the pretest 57% to 89% were able to do the item correctly on the posttest. The number changing positively (that is, from - to +) was significant at the given level within the group of all who changed (that is, + to - and - to +). At age three the trends indicated above continued. Fewer children, 4% to 18% were successful on the pretest. The percent learning declined somewhat, but the number changing positively was significant for all items.

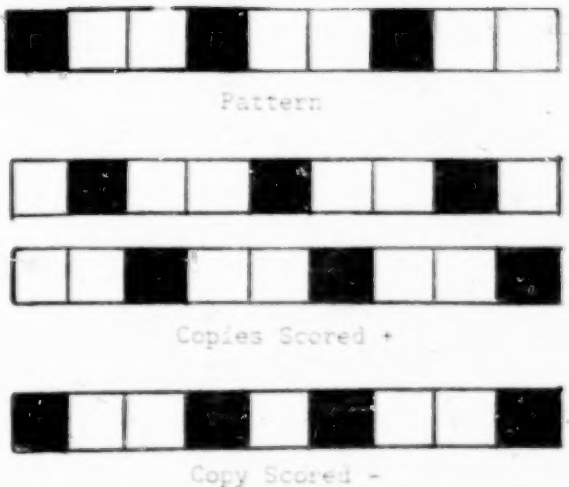


Figure 6

TABLE 2

COPYING PATTERNS

AGE 5

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	35	1	0	1	95%	*	*	N.S.
2	31	1	1	4	86%	*	*	N.S.
3	35	1	0	1	95%	*	*	N.S.
4	36	1	0	0	97%	*	*	N.S.
5	33	1	0	3	89%	*	*	N.S.

TABLE 3

COPYING PATTERNS

AGE 4

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	38	3	3	24	60%	89%	83.0-95.0	$P < .001$
2	20	16	6	26	38%	62%	54.5-69.5	$P < .001$
3	28	4	3	33	46%	89%	83.9-94.1	$P < .001$
4	39	6	4	19	63%	76%	67.5-84.5	$P = .002$
5	28	15	5	20	49%	57%	46.6-65.4	$P = .003$

TABLE 4

COPYING PATTERNS

AGE 3

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	9	10	0	30	18%	75%	68.2-81.8	P<.001
2	5	17	0	27	10%	61%	53.7-68.3	P<.001
3	3	12	1	33	8%	73%	66.6-79.4	P<.001
4	7	16	1	25	16%	61	53.4-68.6	P<.001
5	2	32	0	15	4%	32%	25.2-38.8	P<.001

Describing Patterns. The subjects were asked to describe the same patterns which they had copied in the test on copying patterns. If the subject failed to copy a pattern correctly he was asked to describe the pattern made by the examiner. The subject was scored correct (+) on the item if, in the judgement of the examiner, he had given a description sufficiently clear and detailed so that the examiner could have constructed the pattern from the description only. A useful technique on these items was to pretend to talk with the subject on the telephone. The subjects then were more inclined to tell about the pattern without pointing to it.

The scores for describing patterns show many of the trends evident in copying patterns. There is a general decrease in the percent scoring + on the pretest over the age range 5 to 3. There is a general decrease in the percent learning, more children learning to do the task over the course of instruction at age 4 than at age 3. Again, at age 5 there were not enough children who scored - on the pretest to make a meaningful determination of the percent learning. When the number changing positively is not significant the percent learning

is not meaningful because the number changing from - on the pretest to + on the posttest and vice versa is not significantly different from chance expectation at the .05 level. This unit appears to have little effect on the children's ability to produce a pattern from a verbal description at any age level.

TABLE 5

DESCRIBING PATTERNS

AGE 5

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	34	0	0	3	92%	*	*	N.S.
2	30	1	1	5	84%	*	*	N.S.
3	33	0	0	4	89%	*	*	N.S.
4	32	1	0	4	86%	*	*	N.S.
5	25	4	1	7	70%	*	*	P =.035

PRODUCING PATTERNS FROM VERBAL DESCRIPTIONS

6	29	2	4	2	78%	*	*	N.S.

TABLE 6

DESCRIBING PATTERNS

AGE 4

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	33	9	4	22	54%	71%	8.1 62.9-79.1	P < .001
2	18	20	8	22	38%	53%	7.5 45.5-60.5	P = .009
3	24	10	1	33	37%	78%	6.3 71.7-84.3	P < .001
4	22	18	13	15	51%	45%	8.7 36.3-53.7	N.S.
5	14	30	6	18	29%	37%	6.9 30.1-43.9	P = .013
PRODUCING PATTERNS FROM VERBAL DESCRIPTIONS								
6	20	21	11	16	46%	43%	8.1 34.9-51.1	N.S.

TABLE 7

DESCRIBING PATTERNS

AGE 3

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	5	23	1	20	12.2%	47%	7.6 39.4-53.6	P < .001
2	3	26	0	20	6.1%	43%	7.3 35.7-50.3	P < .001
3	6	23	0	20	12.2%	47%	7.6 39.4-54.6	P < .001
4	7	23	1	18	16.3%	42%	7.7 34.3-49.7	P < .001
5	0	35	2	12	4.1%	26%	6.3 19.7-32.3	P < .008
PRODUCING PATTERNS FROM VERBAL DESCRIPTIONS								
6	3	37	3	6	12.2%	14%	5.3 8.7-19.3	N.S.

Extending Patterns. The subjects were asked to extend the patterns which they had copied earlier. If a subject failed to make a correct copy he was asked to extend the pattern made by the examiner. A subject was scored + on these items if he was able to make one complete repetition of the pattern. In the figure below, starting from A the result B would be scored - because no complete repetition of the pattern has been added to A. The result C would be scored + because a complete pattern element ( ) has been added to A.

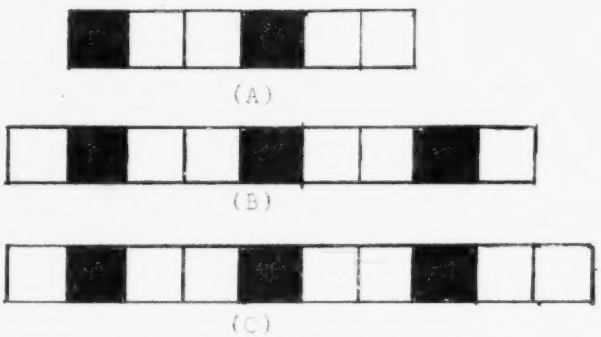


Figure 7

TABLE 8

EXTENDING PATTERNS

AGE 5

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	30	1	0	6	81%	*	*	P = .016
2	17	3	3	14	54%	82%	*	P = .006
3	27	2	0	8	73%	*	*	P = .004
4	3	26	3	5	16%	16%	9%-23%	N.S.
5	9	8	2	17	30%	68%	59%-77%	P = .001

TABLE 9

EXTENDING PATTERNS

AGE 4

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	28	12	1	27	43%	69%	61.6-76.4	P < .001
2	10	33	0	25	15%	43%	36.6-49.8	P < .001
3	11	23	0	34	16%	59%	52.5-65.6	P < .001
4	0	60	5	3	7.3%	*	*	N.S.
5	2	40	1	25	4.4%	38%	32.0-44.0	P < .001

TABLE 10

EXTENDING PATTERNS

AGE 3

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	4	23	0	22	8.2%	49%	41.6-56.4	P < .001
2	0	42	0	7	0%	14%	9.1-18.9	N.S.
3	1	37	0	11	2.0%	23%	16.9-29.1	P < .001
4	0	48	0	1	0%	*	*	P = .02
5	0	45	0	4	0%	8%	4.2-11.8	N.S.

The task of extending patterns is more difficult than copying or describing a pattern. The percent scoring + on the pretest is lower than for the other tasks. The percent learning is also lower and shows the same general trend to be smaller for younger children. The unit had a general significant positive effect on the ability of children to extend patterns but some items appear to be quite difficult, particularly for three year olds.

Patterns of Other Sorts. A six item pretest and posttest was given to investigate the degree to which the instruction involving patterns of blocks in two colors would effect the subjects' performance in extending patterns in other modes. The items involved patterns in sequences of shapes, sizes, and numbers of dots. The results indicate, in general, a somewhat smaller percent of subjects scoring + on the pretest and fewer examples of significant improvement during the course of instruction.

TABLE 11

EXTENDING PATTERNS OF OTHER SORTS

AGE 5

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	24	1	1	7	76%	*	*	P = .035
2	11	10	6	6	52%	38%	*	N.S.
3	24	0	1	8	76%	*	*	P = .020
4	28	0	2	3	91%	*	*	N.S.
5	18	4	1	10	57%	71%	*	P = .006
6	8	12	1	9	27%	43%	*	P = .011

TABLE 12

EXTENDING PATTERNS OF OTHER SORTS

AGE 4

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	38	5	3	18	60%	78%	69.4-86.6	P < .001
2	20	6	5	33	37%	85%	79.3-90.7	P = .001
3	40	5	5	14	66%	74%	63.9-84.1	P = .032
4	41	3	2	18	63%	86%	78.5-93.5	P < .001
5	25	17	6	16	46%	48%	39.4-56.6	P = .026
6	14	29	9	12	34%	29%	21.9-36.1	P = .032

TABLE 13

EXTENDING PATTERNS OF OTHER SORTS

AGE 3

Item	++	--	+-	-+	% Scoring + On Pretest	% Learning	Expected Range	Number Changing Positively
1	23	12	4	8	57.5%	40%	29.1-50.9	N.S.
2	17	13	7	10	51.0%	43%	32.7-53.3	N.S.
3	18	5	7	17	53.0%	77%	68.1-85.9	P = .03
4	15	10	9	13	51.0%	57%	46.4-67.6	N.S.
5	4	19	10	14	30.0%	42%	33.4-50.6	N.S.
6	2	24	5	16	18.0%	40%	32.3-47.7	P = .005

The items in the test on extending patterns of other sorts were different in that the child had only to choose from a supply of cards the one he thought would correctly extend the pattern. This means that the probability of obtaining a correct response by chance is approximately .50. For the previous tests the probability of obtaining a correct response by chance is close to zero. Note that the 3 year olds have approximately 50 percent correct before instruction, a reflection of the probability discussed above. In general, the three year olds were not successful after the unit had been taught. Transfer effects from this unit to patterns of other sorts is notable at age 4, but not at age 3. It seems that extending patterns should be placed at the 4 year old age level where transfer effects are evident.

Information From Time Reports

Few firm conclusions can be drawn from the existing data regarding the time spent on the unit. The reasons for this are (1) it was necessary to terminate instruction at a fixed time and, (2) the teachers (with one exception) utilized daily instructional periods of relatively uniform length. Consequently the differences in instructional time which we anticipated would appear when "faster" groups were compared with "slower" groups failed to materialize. The statements made regarding instructional time spent on the unit are regarded as hypotheses for investigation in further trials of the unit rather than firm conclusions.

Age 5. The record of time spent on the unit by the two teachers of five-year-olds is contained in table 14, and is also illustrated in Table 15. Although the teachers were substantially different in the number of days which they used to complete the unit they spent virtually the same number of minutes of class time for instruction. In further trials one might hypothesize

that, for five year olds, the number of minutes of class time necessary to satisfactorially complete the unit would be fairly stable for 5 year olds even though the teachers distribute these minutes over different numbers of days.

Age 4. The teachers of four year olds used from 4 hours 20 minutes to 5 hours 20 minutes of instructional time distributed over 18 to 20 days. Teacher C used more time teaching the children which she had identified as "slower learners" while teacher D did not. It appears that the need for more instructional time is greatest in Activity Sequence II; the bulk of the increased time taken by teacher C with slower children occurs there.

Age 3. From the progression of the data in table 14 it is clear that in the time provided the five year olds had a reasonable opportunity to complete the unit. The four year olds did complete the unit but the data suggests a rush at the end to finish within the time restriction. In each case one of the last three Activity Sequences was reduced to one day in order to move the children along. This is, of course, far from ideal educational practice. The three year olds were even more rushed in their attempts to complete the unit. In no case did they attempt Activity Sequences IV or V. Activity Sequences II and III were combined by the teachers in such a way that separate reporting of time spent was not possible.

TABLE 14

INSTRUCTIONAL TIME

Activity Sequence:		I		II		III		IV		V	
Time: Days & Minutes		D	M	D	M	D	M	D	M	D	M
	Teacher										
5 Year Olds	A	5	80	7	100	8	120	2	30	5	50
All Groups	B	2	30	5	140	6	100	2	50	3	60
4 Year Olds	C	3	40	9	120	4	60	1	15	1	15
Group 1	C	3	45	9	120	5	75	1	15	1	15
	D	3	39	11	142	1	10	2	25	3	40
	D	3	39	11	147	1	10	2	20	3	40
4 Year Olds	C	3	40	10	150	4	60	1	15	1	15
Group 2	C	3	45	9	130	5	75	1	15	1	15
	D	3	39	11	142	1	10	2	25	3	40
	D	3	39	11	147	1	10	2	20	3	40
4 Year Olds	C	3	40	9	175	5	75	1	15	1	15
Group 3	C	3	45	9	130	5	75	1	15	1	15
	D	3	39	11	147	1	10	2	30	3	40
	D	3	39	11	147	1	10	2	30	3	40
3 Year Olds	E	3	30	20	235	*					
All Groups	E	3	30	17	195						
	F	3	30	21	220						
	F	3	30	18	195						

*Some of the time reported for the 3 year olds under Activity Sequence II was in fact spent on Sequence III but the exact distribution is unknown.

TABLE 15

INSTRUCTIONAL TIME FOR FIVE YEAR OLDS

IN HOURS AND DAYS FOR

ACTIVITY SEQUENCES I, II, III, IV AND V

Conclusions

The unit "Patterns" composed of five activity sequences is teachable; that is, the activities which have been described are such that children will participate in them willingly and teachers using the material are comfortable with it.

The unit is, in the main, successful in accomplishing the goals of instruction. In general, a fairly satisfactory number of children learned, between pre and post testing, to do each item. The five year old children could perform well on the easier items at the time of the pretest and consequently no reliable percent of five year olds learning to do these items could be calculated. The harder items were missed by the three year olds at the time of post testing. It seems that these more difficult tasks should be included for children four and older, but not for three year olds.

The time taken for the unit will vary, if teachers are permitted to follow their preferences, with the age of the children and with the teachers' perceptions of children as "faster" and "slower." The teachers of most groups reported that the time spent on the unit could not have been profitably extended as the children were reaching the limit of their attention span. The five year olds finished easily, the four year olds were rushed but finished, and the three year olds did not finish. Segmenting the unit and assigning parts to different age levels would seem to be a reasonable solution to this problem of attention span and the need to assign materials to appropriate age levels.

APPENDIX A

PATTERNS

Pre- and Posttest

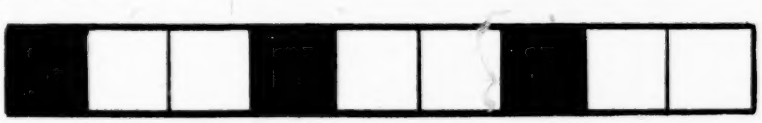
Part A

1. General Directions: To find out what the child is presently able to do we must help him to understand the task but not show him how to do it! Use any words which communicate to the child what he is to do but do not show him how to do it.

   1. Examiner makes a row of blocks having a 2-2 pattern.
   2. "Now you make a row of blocks which looks just exactly like my row." or use other words to help the child understand what he is to do.
   3. a. If the child does make a copy successfully say "Now make your row longer but keep the same pattern" or use other words to help the child understand.
      b. If the child does not make a copy successfully put your row of blocks in front of him and say "Make this row longer but keep the same pattern," or use other words to help the child understand.
   4. "Describe this row of blocks (his row if he has it right, otherwise yours), tell me how it looks." Use other words to help the child understand.

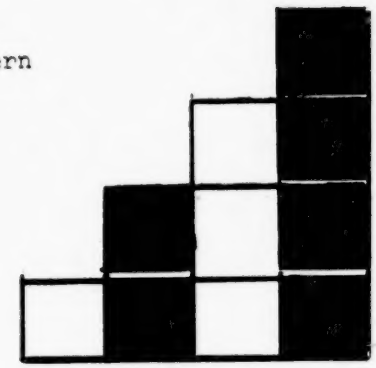
2. Use pattern 4-1

3. Use Pattern 1-2



4. Use Pattern 1-2-3

5. Use Pattern



6. "Make a pattern which goes white, red, red, white, red, red, white, red, red."

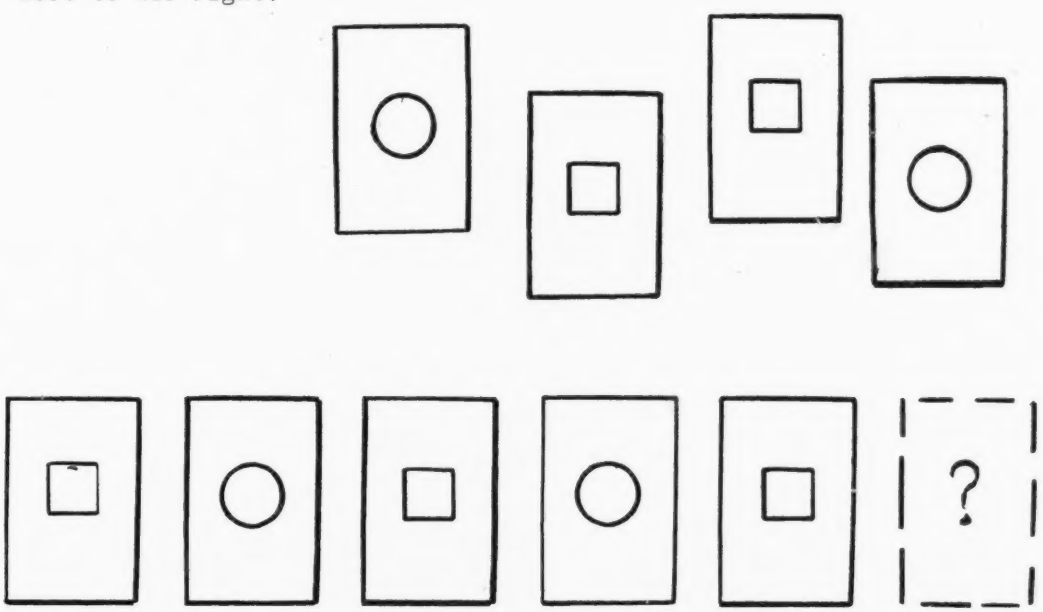
PATTERNS

Pre- and Posttest

Part B

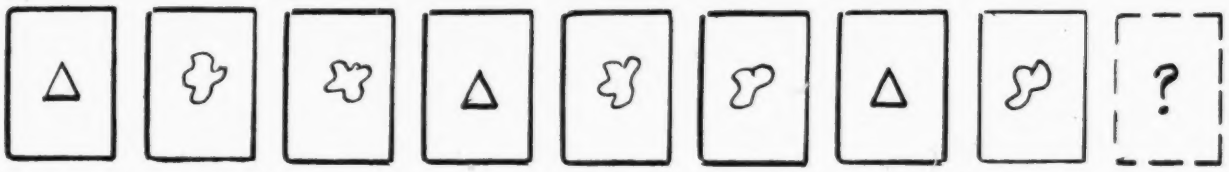
General Directions: In each item you will place in a row in front of the child a sequence of cards. The child will be asked to pick the next card from a supply pile. The supply pile should consist of the same items used in the sequence. Item 1 is fully illustrated and the other 5 items are to be done similarily.

1. Say "Watch me place these cards" then place the cards shown, the 1 inch squares and circles, one at a time in front of the child from the child's left to his right.

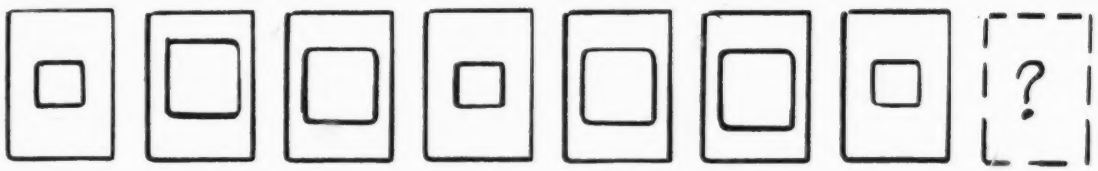


Ask the child "Pick the card you think should go next in this row." Record on the score sheet either + (correct), - (not correct), or 0 (no response).

2. Use the sequence:

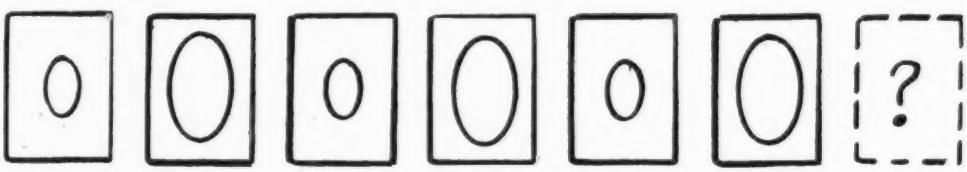


3. Use the sequence:

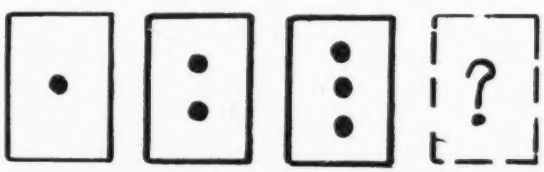


(1/2 in. squares and 2 in. squares)

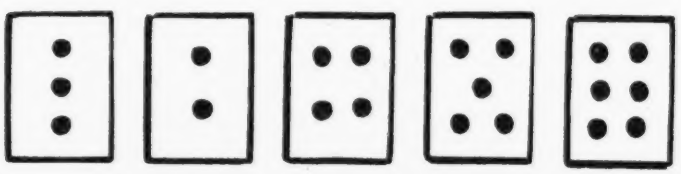
4. Use the sequence:



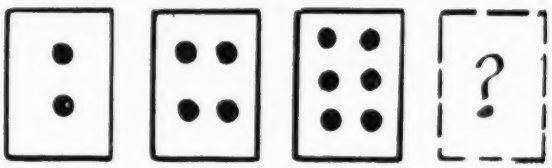
5. Use the sequence:



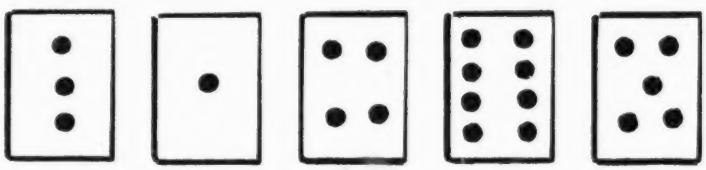
Supply pile:



6. Use the sequence:



Supply pile:



APPENDIX B

TIME IN MINUTES PER SESSION

TEACHER _____

Morning Class

GROUP	DATE																									
	1																									
	2																									
	3																									

Afternoon Class

GROUP	DATE																									
	1																									
	2																									
	3																									

ACTIVITY SEQUENCE 2

TEACHER _____

GROUP _____

CHILD _____

DATES ABSENT _____

Marking

/A/ The child attempted the activity one or more times but did not succeed

/AS/ The child succeeded after one or more unsuccessful attempts

/S/ The child succeeded on the first attempt

In marking this sheet the child should be marked absent if he misses mathematics period for any reason.

Copying Teacher-Made Patterns

PATTERN	DATE													
	A													
	B													
	C													
	D													
	E													
	F													
	G													
	H													
	I													
	J													

Copying Patterns From Large Squares

PATTERN	DATE													
	A													
	B													
	C													
	D													
	E													
	F													
	G													
	H													
	I													
	J													

Producing Patterns From Descriptions

PATTERN	DATE													
	A													
	B													
	C													
	D													
	E													
	F													
	G													
	H													
	I													
	J													

Describing Patterns

PATTERN	DATE													
	A													
	B													
	C													
	D													
	E													
	F													
	G													
	H													
	I													
	J													

ACTIVITY SEQUENCE 3

TEACHER _____

GROUP _____

CHILD _____

DATES ABSENT _____

Marking

/A/ The child attempted the activity one or more times but did not succeed

/AS/ The child succeeded after one or more successful attempts

/S/ The child succeeded on the first attempt

In marking this sheet the child should be marked absent if he misses mathematics period for any reason.

Extending Patterns

PATTERN	DATE												
	A												
	B												
	C												
	D												
	E												
	F												
	G												
	H												
	I												
	J												

ACTIVITY SEQUENCE 4

TEACHER _____

GROUP _____

CHILD _____

DATES ABSENT _____

Marking

/A/ The child attempted the activity one or more times but did not succeed

/AS/ The child succeeded after one or more successful attempts

/S/ The child succeeded on the first attempt

In marking this sheet the child should be marked absent if he misses mathematics period for any reason.

Copying Teacher-Made Patterns

PATTERN	DATE												
	K												
	L												
	M												
	N												
	O												

Extending Patterns

PATTERN	DATE												
	K												
	L												
	M												
	N												
	O												

ACTIVITY SEQUENCE 5

TEACHER _____

GROUP _____

CHILD _____

DATES ABSENT _____

Marking

/$\overline{A}$/ The child attempted the activity one or more times but did not succeed

/$\overline{AS}$/ The child succeeded after one or more successful attempts

/$\overline{S}$/ The child succeeded on the first attempt

In marking this sheet the child should be marked absent if he misses mathematics period for any reason

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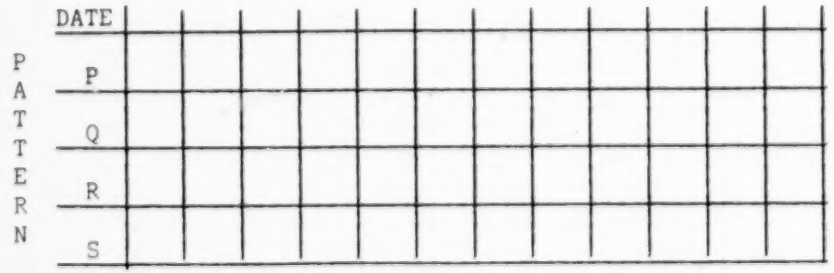
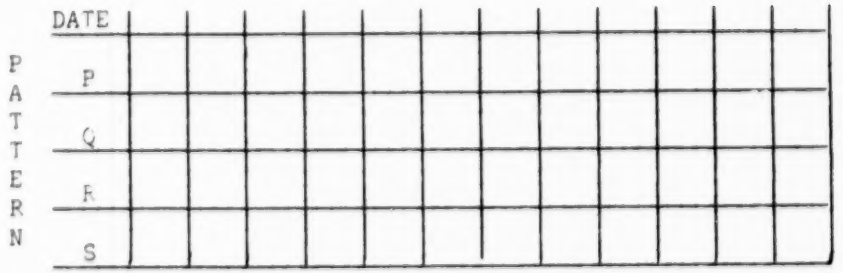
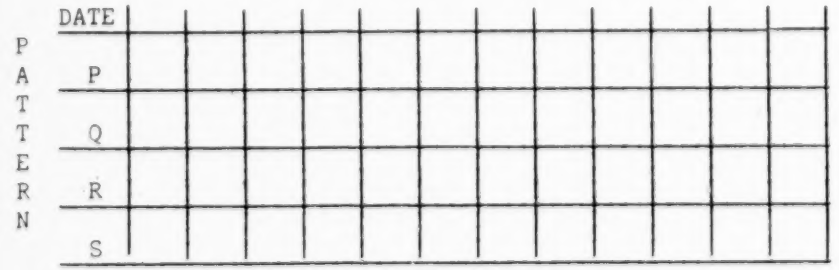
Copying Teacher-Made Patterns



Extending Patterns



Producing Patterns From Descriptions



Describing Patterns